

RSRM Propellant Grain Geometry Modification

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● Objective

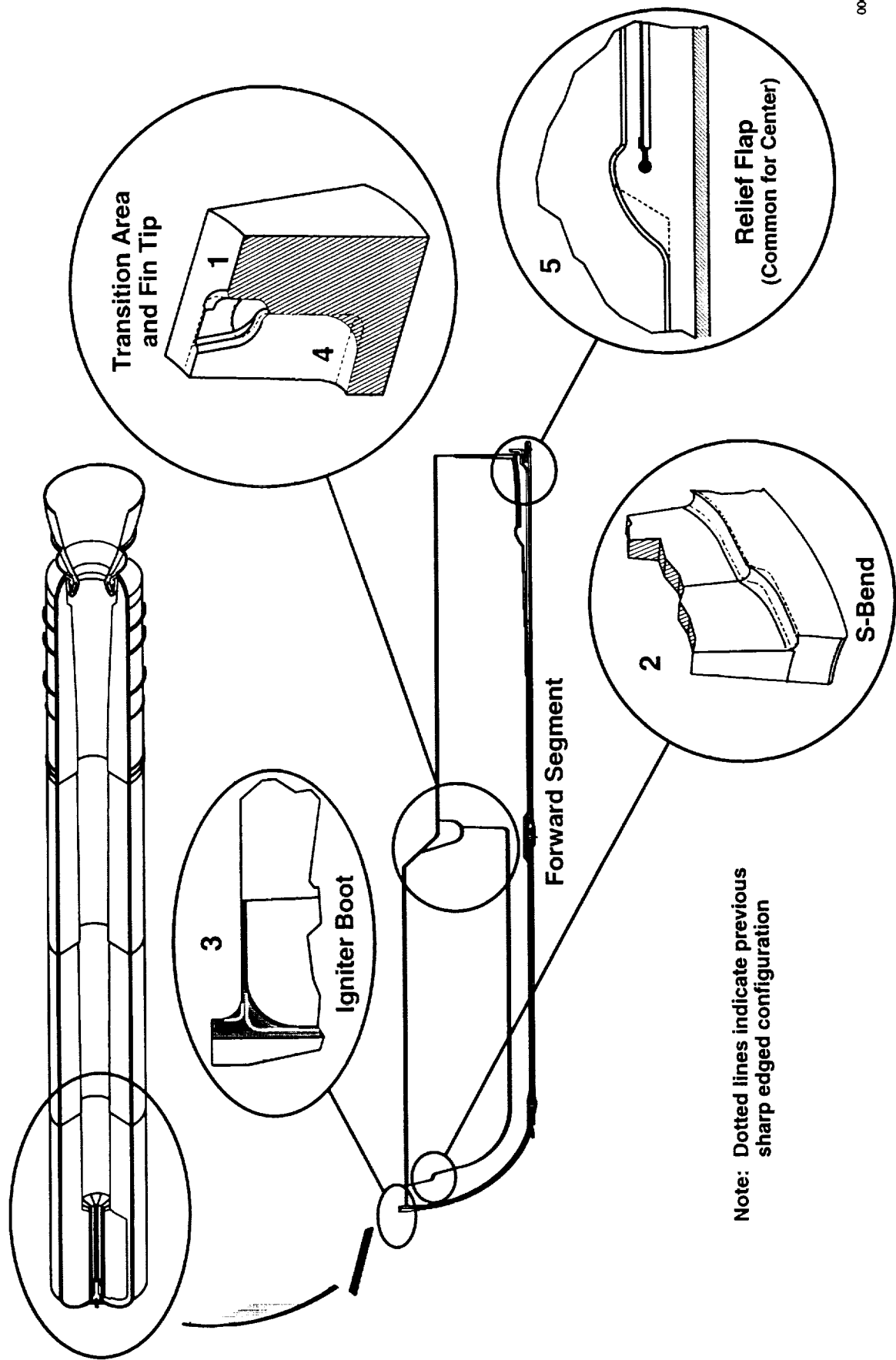
- *IMPROVE PERSONNEL AND SYSTEM SAFETY* by modifying propellant grain geometry to improve structural factors of safety
 - Personnel risk; exposure to hazardous operations
 - Potential system risks; over pressurization and premature flame at case wall

● Background

- CEI specification structural requirements for propellant grain are below a 2.0 safety factor due to localized induced loads. Five regions exist:

| | <u>Region</u> | <u>Current SF</u> <u>Upgrade SF Requirement</u> | | <u>Controlling CEI Condition</u> |
|----|-------------------------|---|------|--|
| | | | | |
| 1. | Transition Area | 1.4 | >2.0 | Transportation $\leq 28^{\circ}\text{F}$ |
| 2. | S-bend | 1.4 | >2.0 | Storage $\leq 40^{\circ}\text{F}$ |
| | S-bend | 1.6 | >2.0 | Launch $\leq 40^{\circ}\text{F}$ |
| 3. | Igniter Boot | 1.4 | >2.0 | Storage $\leq 40^{\circ}\text{F}$ |
| | Igniter Boot | 1.6 | >2.0 | Launch $\leq 40^{\circ}\text{F}$ |
| 4. | Fin Tip | 1.4 | >2.0 | Storage $\leq 40^{\circ}\text{F}$ |
| 5. | Fwd & Ctr Flap Terminus | 1.4 | >2.0 | Storage $\leq 40^{\circ}\text{F}$ |

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- **Propellant/liner/insulation modification will...**
 - Reduce high-stress or strain regions in the propellant grain by reducing sharp corners in the geometry
 - Modify grain forming tooling
 - Modify insulation lay-up
 - Reduce the time operators and inspectors at Thiokol and KSC spend in a hazardous environment inside the motor
 - Significantly reduce propellant trimming and associated inspections in the areas of profile changes
 - Eliminate the re-inspection criteria at KSC after 6 months storage and any rotation operation to accomplish the inspection
 - Increase schedule flexibility at KSC
 - Enhance risk mitigation to include both inspection and design
 - Provide a more robust structural design, less sensitive to variation (obsolescence driven raw material changes, nonconformances, and contamination issues)

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- **Proposed approach**

- Analytical

- Use parametric design techniques with Finite Element Analysis to determine blend radii required to reduce localized stresses for storage, transportation and launch
- Ballistic predictions will ensure that the ballistics, ignition transient, and Block Model have not been adversely affected (including mass properties)

- Tooling

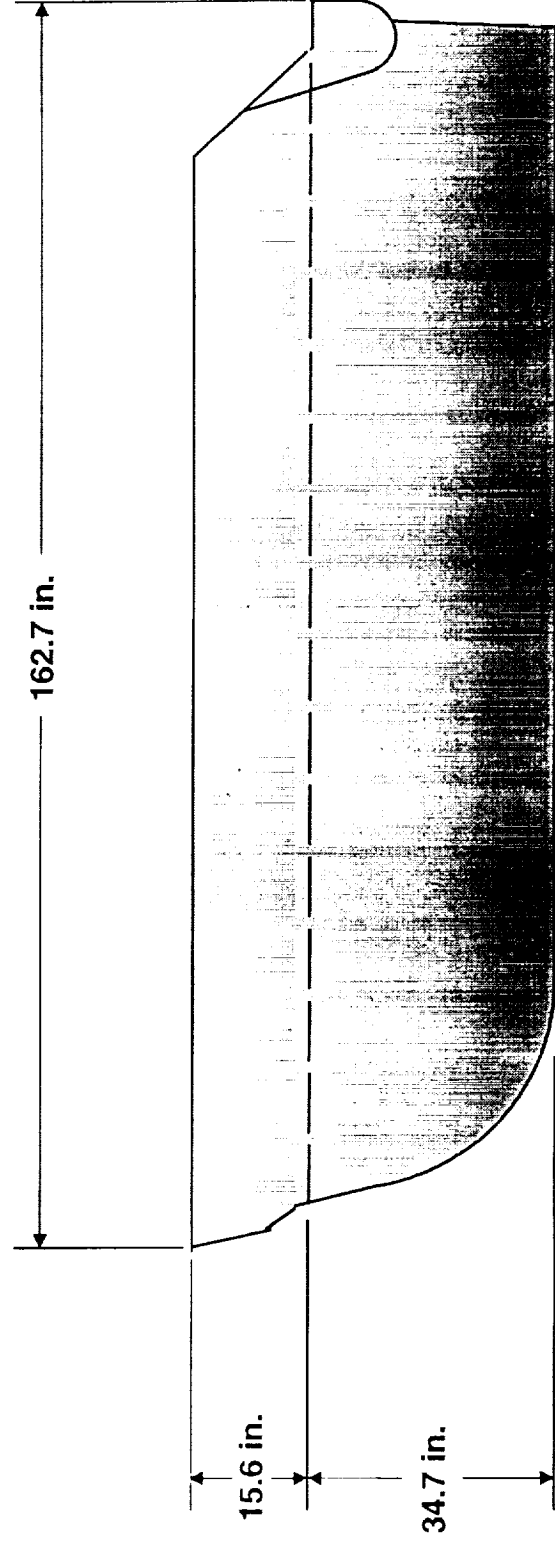
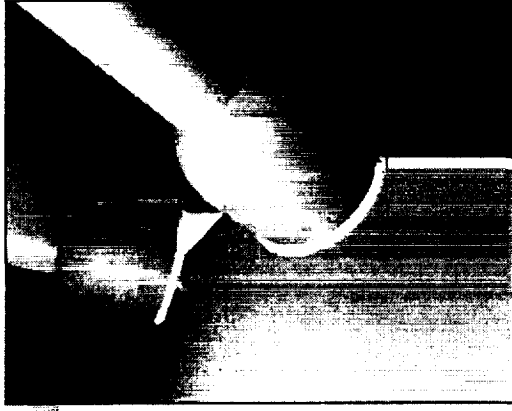
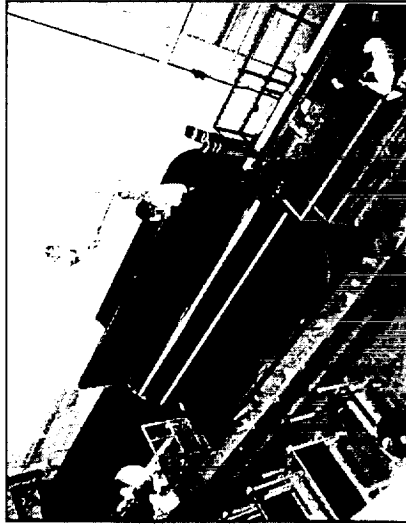
- Define insulation configurations and tooling
- Build pathfinder and checkout hardware
- Define loaded segment design configurations and tooling
- Fabricate tooling
 - Modify existing clevis and igniter mold rings
 - New stub fins and fin tip formers
 - Modify existing filler ring, fin puller, fin base spider and fin retainers

- Build and test

- Build and test FSM-10 with new design (April 2002)
- Determine flight effectivity pending successful test evaluation
- Implement first flight production (approx. November 2002)

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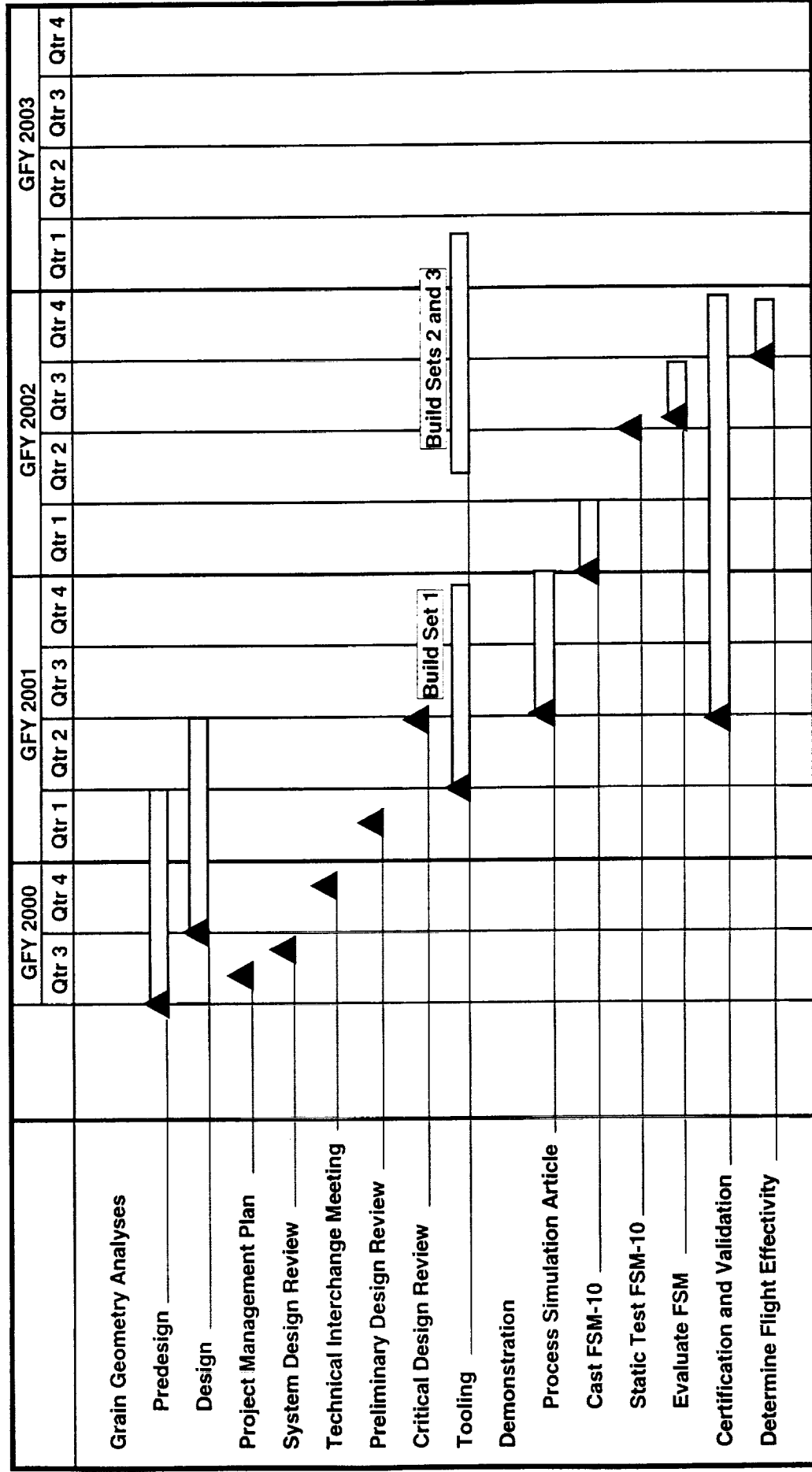
PRESENT DESIGN



Approximately 4 in. thick

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● End-to-end project - 3 years



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- Preliminary Req'ts Review Jun 28, 2000
- Preliminary Design Review Nov 15, 2000
- Critical Design Review Apr 2, 2001
- Static Test FSM-10 Apr 2002

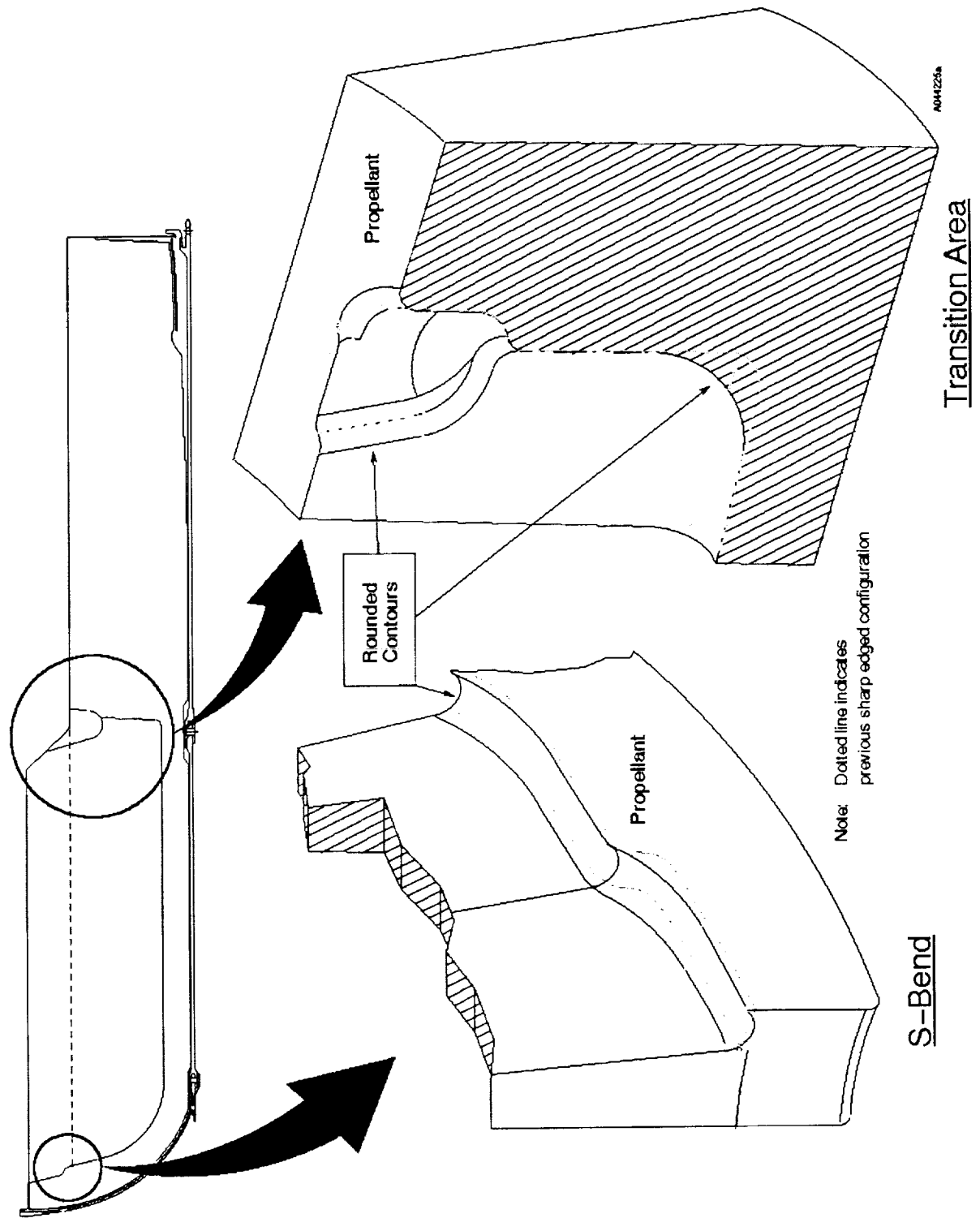
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- **Summary**
 - **The proposed upgrade will:**
 - Enhance RSRM *SAFETY* and *RELIABILITY* by modifying the propellant grain geometry
 - Make the RSRM more robust
 - Increase the propellant structural factors of safety in forward and center segments by eliminating regions of concentrated stress
 - Improve personnel and system safety by eliminating operations in hazardous environments in the motor
 - Reduces propellant trimming
 - Eliminates re-inspections
 - Reduces segment handling, moves, and rotation
 - Increases schedule flexibility at KSC
 - ***THE PAYBACK ON THIS UPGRADE IS IN ENHANCED PERSONNEL SAFETY AND MOTOR RELIABILITY***

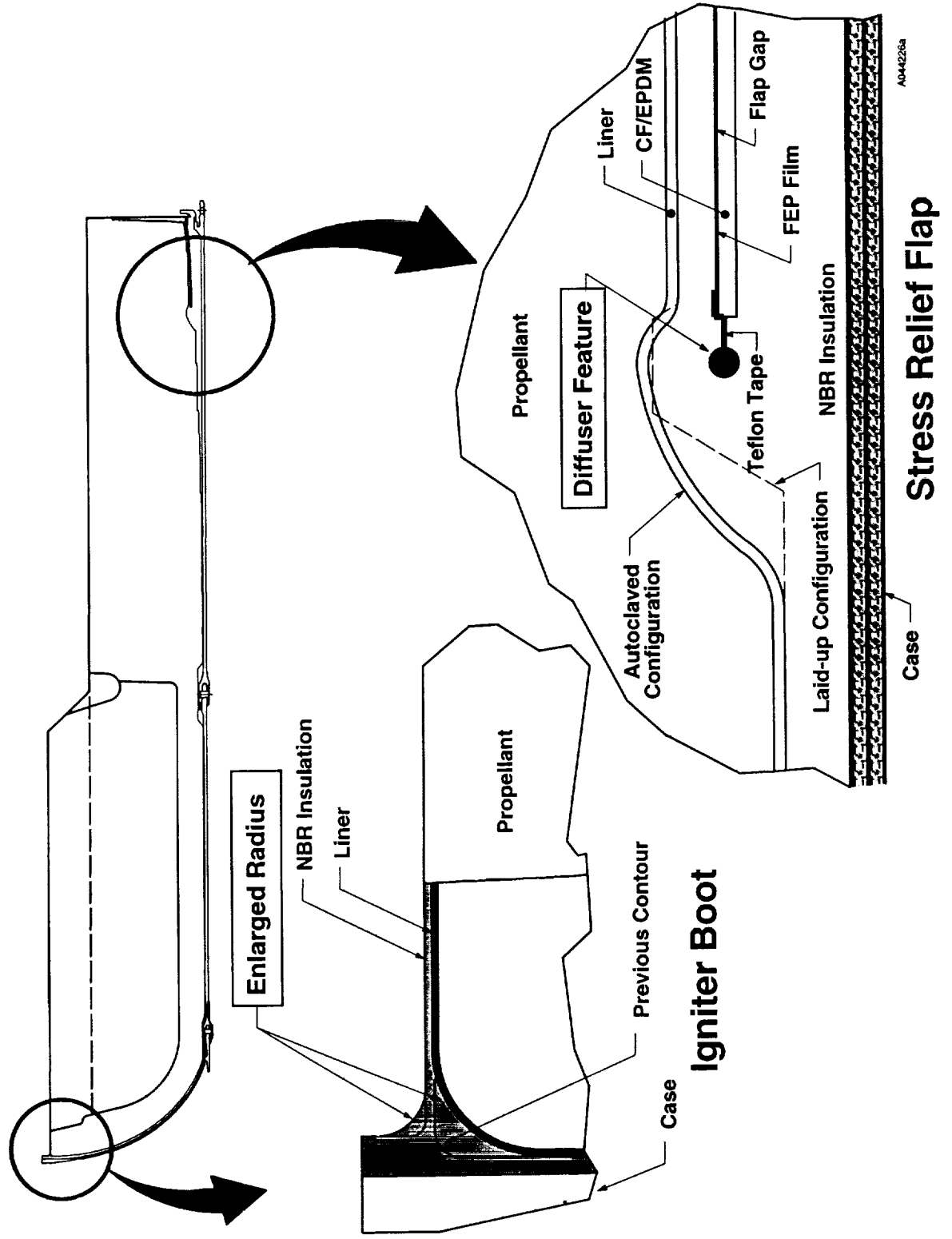
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Supporting Illustrations

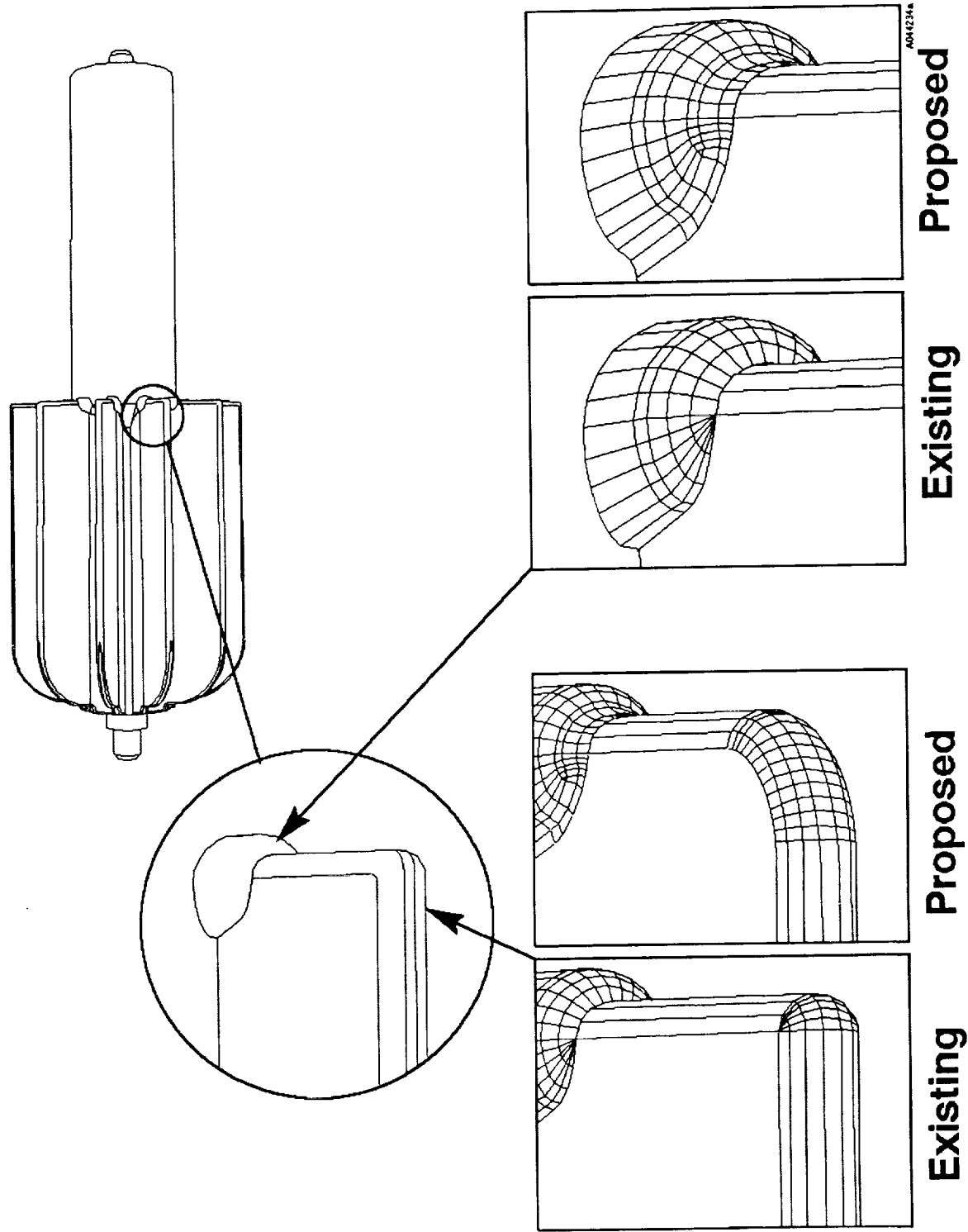
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1. The first part of the document is a title page. It contains the title "THE HISTORY OF THE UNITED STATES OF AMERICA" and the author "BY JAMES MADISON".

2. The second part of the document is a preface. It contains the text "I have the honor to acknowledge the receipt of your letter of the 10th inst. and in reply to inform you that the same has been forwarded to the proper authorities for their consideration."

3. The third part of the document is the main body of the text. It contains the text "The first part of the document is a title page. It contains the title 'THE HISTORY OF THE UNITED STATES OF AMERICA' and the author 'BY JAMES MADISON'."

4. The fourth part of the document is a conclusion. It contains the text "I have the honor to acknowledge the receipt of your letter of the 10th inst. and in reply to inform you that the same has been forwarded to the proper authorities for their consideration."

